DRAFT

Memorandum

TO: Regional Transportation Authority (RTA)
Chicago Metropolitan Agency for Planning (CMAP)
Chicago Transit Authority (CTA)
Metra Rail
Pace Suburban Bus

FROM: Cambridge Systematics, Inc.

DATE: November 18, 2009

RE: Adjustment of Expansion Weights in the CMAP Travel Tracker Survey

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This technical memorandum provides a detailed discussion of the adjustments that Cambridge Systematics made to the expansion weights in the CMAP travel tracker survey (referred to as CMAP survey for the rest of this document). **Section 1** discusses the background and context of the CMAP survey analysis. **Section 2** provides an overview of the CMAP survey and its contents, and identifies issues with the original expansion weights. **Section 3** describes the "tiered" adjustment methodology for households, persons, and trips. **Section 4** presents additional comparative results with the adjusted weights. Finally, **Section 5** presents the summary and conclusions.

1.0 Background

RTA retained Cambridge Systematics in December 2008 to conduct the Travel Market Analysis study. This study is geared towards establishing a baseline understanding of travel demand, documenting the role of transit in serving different geographic markets, and identifying existing or perceived barriers to transit use. The study comprised two major tasks:

- The first task deals with the quantification of magnitude and distribution (both geographic and temporal) of regional travel flows. This task relied almost exclusively on the CMAP survey to conduct an analysis of the nearly 3 million households, 8 million residents, 26 million daily trips, and roughly two million daily trips served by CTA, Metra, and Pace.

- The second task involved administering a survey of riders and non-riders to "gauge the pulse" of the traveling public in the Chicago region. Specifically, this task was designed to identify distinct market segments and uncover real and perceived barriers to transit use. This analysis is expected to guide the development of service approaches and marketing strategies to help remove these barriers in different markets and segments of the population.

The CMAP survey is therefore a critical data source for the Market Analysis project. Before using the survey data, CMAP recommended that RTA and CS conduct a thorough review of the

purpose and scope of the survey, and the expansion factors that were generated by NuStats as part of the data collection effort. The next section provides a brief overview of the CMAP survey and lists the issues with the expansion factors that were uncovered as part of the preliminary analysis.

2.0 CMAP Survey Overview and Issues with Weights

The primary objective of the CMAP survey was to provide data for the continuing development and refinement of the Chicago regional travel demand forecast models[1]. The survey covered six counties in Illinois and three in Northwest Indiana. It was administered between January 2007 and March 2008 and sampled about 10,400 households and 23,500 individuals in the six-county area (**Figure 1**). The survey elicited travel diary responses from the sampled households on randomly assigned 24 or 48-hour periods, and included about 77,600 trip records for the six-county area.

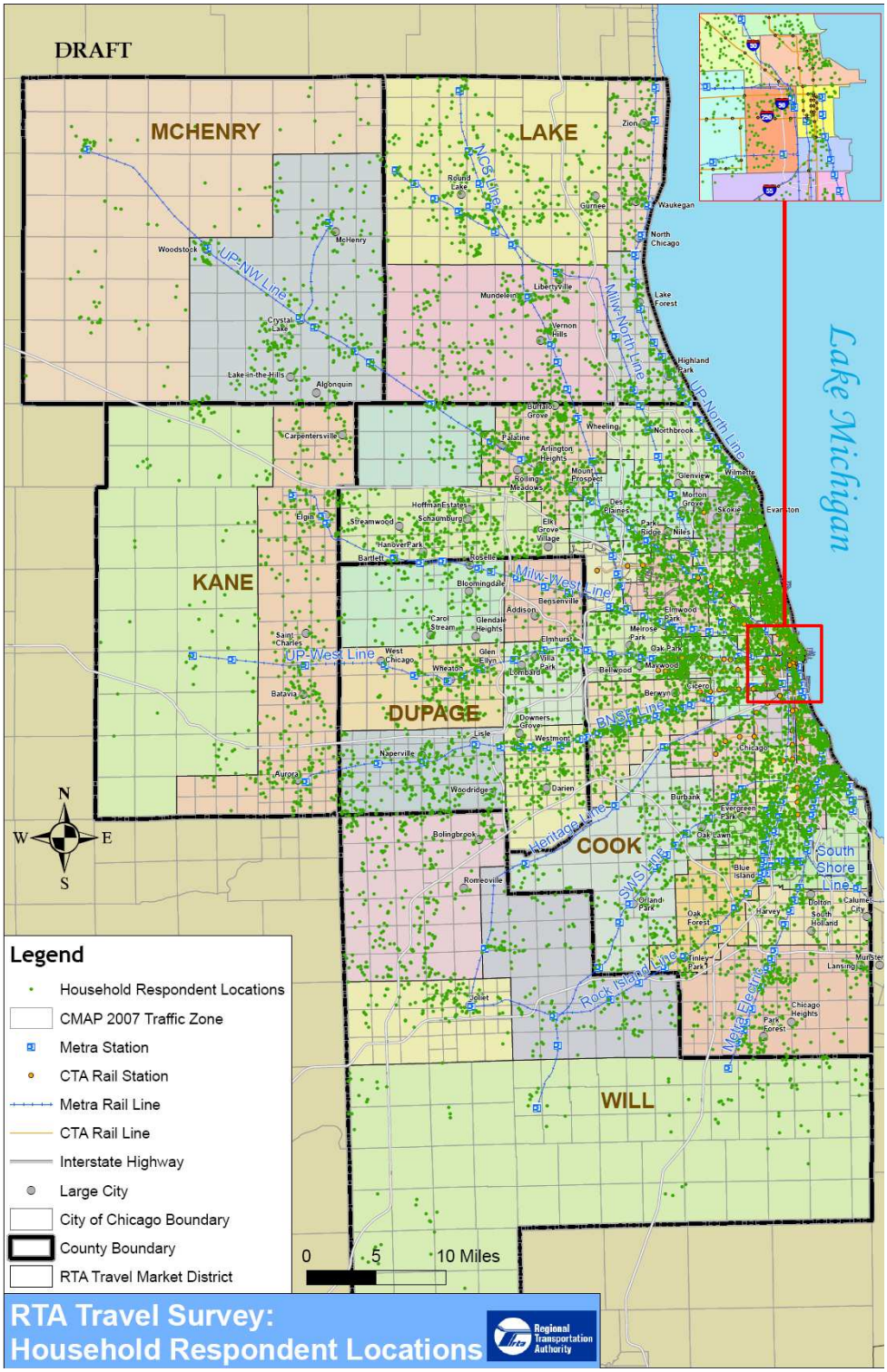
The survey was designed by a team of consultants, led by NuStats. NuStats also managed data collection, processed and geocoded the data, provided quality control and assurance, summarized the survey data, and developed the expansion methodology and resulting weights. The weights included with the data set were derived by comparing the sample data's demographics to actual population demographics by county. Factors included in the original weighting calculation included race/ethnicity, household size, household income, and age of householder.

While the weights were derived using statistically rigorous iterative proportional fitting techniques, certain households received expansion weights over 40,000 and few other households received expansion weights less than 1 (**Table 1**). This was most likely due to the under-or over-representation of households with certain combinations of geography, race, size, income, and age of householder. Further, the large expansion weights meant that a mere 19 household records accounted for nearly 27% of the overall weighted household total. **Figure 2** shows the geographic distribution of households with high and low weights.

Given these issues, CMAP recommended that CS and RTA make necessary adjustments to the original weights to conduct the travel market analysis. The next section describes in detail the steps taken by CS to adjust the CMAP weights.

[1] http://www.cmap.illinois.gov/uploadedFiles/regional_data/TravelTrackerSurvey/TravelTrackerSurveyDataUsersManual.pdf

Figure 1. Geographic Distribution of Sampled Households in the CMAP Survey



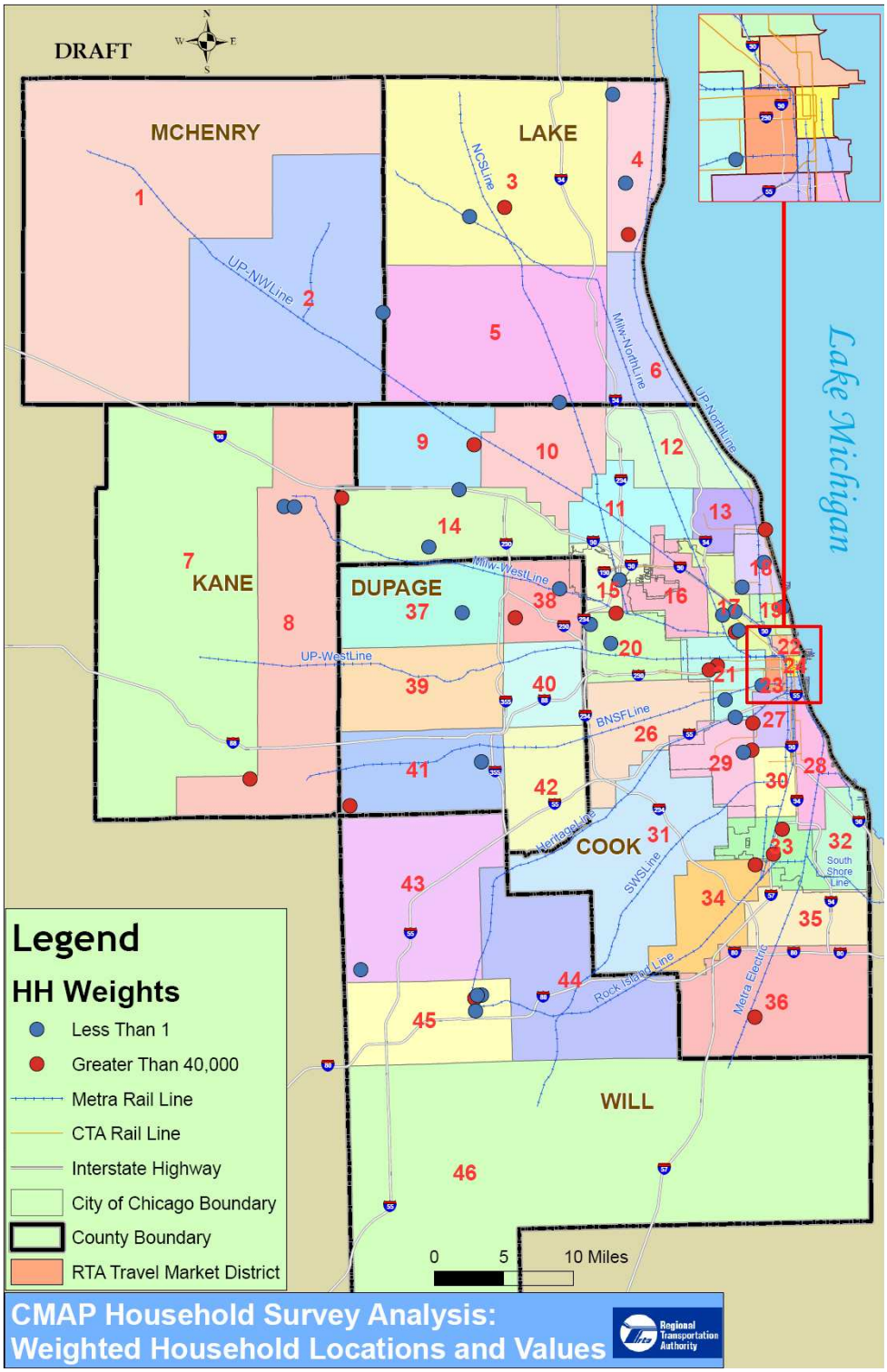
Source: CMAP Travel Tracker Survey and Cambridge Systematics

Table 1. Attributes of households with very large (>40,000) and very small (<1) weights

HH ID	Household Size	Vehicles	Income	County	Language of Survey	Original Weight
4113756	4	0	Less than $20,000	Cook County, IL	English	46520.1292
4252081	3	0	$35,000 - $49,999	Cook County, IL	English	46514.7295
4264566	4	3	$60,000 to $74,999	Kane County, IL	English	46423.1723
4161770	3	3	Refused	Cook County, IL	English	46379.2177
4270514	3	3	More than $100,000	Cook County, IL	English	46368.1123
4472367	3	3	More than $100,000	Cook County, IL	English	46368.1123
4001185	2	1	$35,000 - $49,999	Cook County, IL	English	46339.0219
4200878	2	2	$20,000 - $34,999	DuPage County, IL	English	46336.9165
4528580	1	3	More than $100,000	Cook County, IL	English	46303.7525
4268954	2	2	$35,000 - $49,999	Lake County, IL	English	46289.6727
4763042	4	3	$75,000 to $99,999	Cook County, IL	Spanish	46054.0748
4523218	4	3	$20,000 - $34,999	Will County, IL	English	46023.5005
4721624	4	2	$60,000 to $74,999	Cook County, IL	English	45976.9457
4154452	4	1	$60,000 to $74,999	DuPage County, IL	English	45947.4858
4561648	1	0	Less than $20,000	Cook County, IL	English	45888.1334
4607209	4	2	Less than $20,000	Cook County, IL	English	43751.6682
4596723	4	2	Less than $20,000	Cook County, IL	Spanish	43337.9585
4584941	4	2	$20,000 - $34,999	Cook County, IL	English	43327.9117
4552896	4	3	Less than $20,000	Lake County, IL	English	43316.0292
4759327	3	1	Refused	Will County, IL	English	0.9762
4759299	1	2	$60,000 to $74,999	Will County, IL	Spanish	0.9433
4760818	4	1	$35,000 - $49,999	Cook County, IL	Spanish	0.8948
4761378	4	2	$75,000 to $99,999	Cook County, IL	English	0.8890
4761978	1	1	$35,000 - $49,999	Cook County, IL	English	0.7881
4764013	2	1	$20,000 - $34,999	Cook County, IL	English	0.7854
4762411	4	3	$60,000 to $74,999	Will County, IL	Spanish	0.6492
4557033	4	3	$35,000 - $49,999	Lake County, IL	English	0.6314
4761448	4	2	$35,000 - $49,999	DuPage County, IL	Spanish	0.6192
4763764	1	0	$20,000 - $34,999	Cook County, IL	Spanish	0.5961
4760519	4	2	$35,000 - $49,999	Will County, IL	English	0.5733
4565241	4	3	$75,000 to $99,999	Cook County, IL	English	0.5415
4759234	2	2	$20,000 - $34,999	Cook County, IL	Spanish	0.5362
4763643	2	2	$20,000 - $34,999	Cook County, IL	Spanish	0.5362
4761258	4	3	More than $100,000	Cook County, IL	English	0.5111
4761769	3	2	$50,000 - $59,999	Kane County, IL	Spanish	0.4795
4760847	3	2	$75,000 to $99,999	DuPage County, IL	English	0.4519
4760245	4	3	$35,000 - $49,999	Lake County, IL	English	0.3988
4763413	3	0	Refused	Lake County, IL	Spanish	0.3807
4759155	1	0	Less than $20,000	Cook County, IL	Spanish	0.3490
4763437	2	1	Refused	DuPage County, IL	Spanish	0.3427
4759488	1	0	$35,000 - $49,999	Cook County, IL	English	0.3315
4763223	4	2	More than $100,000	McHenry County, IL	English	0.2993
4759054	2	3	More than $100,000	Lake County, IL	English	0.2103
4762721	4	3	$35,000 - $49,999	Cook County, IL	Spanish	0.1650
4761049	4	2	Refused	Cook County, IL	Spanish	0.1355
4761955	4	3	More than $100,000	Kane County, IL	English	0.1083
4761941	4	2	Refused	Cook County, IL	Spanish	0.1063
4762236	4	2	$35,000 - $49,999	Cook County, IL	Spanish	0.0925

Source: CMAP Travel Tracker Survey and Cambridge Systematics

Figure 2. Location of households with very large (>40,000) and very small (<1) weights



Source: CMAP Travel Tracker Survey and Cambridge Systematics

3.0 CMAP Weight Adjustment Methodology

The original CMAP weights were derived using a rigorous iterative proportional fitting technique that attempted to match the survey distributions to those from the Census along several dimensions including geography, race, size, income, and age of householder[2]. Beyond attempting to match these socio-economic distributions, these weights also incorporated adjustments for non-response biases and multiple phone lines. Therefore, the very large and small weights notwithstanding, the methodology behind the derivation of weights was generally sound. Keeping this in mind, the CS adjustment methodology focused on using the original weights as a starting point and making incremental changes to correct for the very large or small weights. It was believed that such an incremental methodology would retain the necessary corrections for non-response and multiple phone lines, while at the same time correcting for the large weights that are most likely a result of divergent iterations during the iterative fitting process.

The CS adjustment methodology consisted of the following four steps:

1. Initial smoothing of weights;
2. Derivation of household-level weights based on a comparison of household distributions by size and vehicle ownership from the survey and ACS 2007;
3. Derivation of person-level adjustments based on a comparison of population distributions by age and gender from the survey and ACS 2007; and
4. Derivation of work trip adjustments based on a comparison of county-to-county journey to work flows from the survey and Census Journey to Work 2000 data.

Each of these steps is discussed below.

3.1 Initial Smoothing of Weights

To eliminate the large weights, CS placed an artificial maximum weight restriction of twelve times the average weight for the entire sample. Similarly, an artificial minimum weight restriction of a twelfth of the average weight was imposed to eliminate weights below 1. These restrictions were based on a similar procedure that NuStats attempted while developing the original weights[3].

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[2] NuStats, Chicago Regional Household Travel Inventory, Technical Memo on Weighting, http://www.cmap.illinois.gov/uploadedFiles/regional_data/TravelTrackerSurvey/TravelTrackerWeighting.pdf

[3] NuStats, Chicago Regional Household Travel Inventory, Technical Memo on Weighting, http://www.cmap.illinois.gov/uploadedFiles/regional_data/TravelTrackerSurvey/TravelTrackerWeighting.pdf, Page 10

Naturally, any artificial "trimming" of the expansion weights would result in a mismatch between the survey and target households. Therefore, CS re-adjusted the trimmed weights on a county-by-county basis to match the survey household totals to the CMAP land use targets.

3.2 Derivation of Household-Level Weights

The trimmed weights described above serve only as a good starting point. They do not represent the final household-level weight because they do not attempt to match the survey household distributions by key socio-economic variables from independent sources. Therefore, the second step in the adjustment methodology is to derive household weights that match not only the overall household totals by county, but also totals of households as categorized by key socio-economic characteristics.

Two variables were used to categorize households: household size and number of vehicles owned by the household. Household size is generally a good indicator of the life cycle aspect of the household, while the number of vehicles is a good indicator of the economic status of the household. These two variables therefore capture both the social and economic makeup of a household.

The American Community Survey (ACS) 2007 was chosen as the independent source with which to compare the survey household distributions. The ACS provides economic, social, demographic, and housing information for the country's communities each year. The ACS 2007 is also temporally comparable to the CMAP survey, which was conducted in 2007 and early 2008.

A step-by-step description of the derivation of household weights is provided below:

1. Use the trimmed weights described in Section 3.1 to summarize the number of survey households by county of residence, household size, and number of vehicles;

2. Summarize the ACS 2007 households categorized by county of residence, household size, and number of vehicles;

3. Compare the households in each county, size and vehicle combination from steps 1 and 2 to derive adjustment factors; and

4. Multiply the adjustment factors to the trimmed weights from Section 3.1 to derive the final household weights.

Table 2 shows the comparison of household distributions by county, size, and vehicles as obtained from the original CMAP household weights, the ACS 2007, and the CS-adjusted household weights. As is evident from this table, the original CMAP weights resulted in household distributions that did not match closely with those from the ACS 2007. The Cook County household distributions provide an example of the mismatch.

Table 2. Distribution of Households by County, Household Size and Vehicles Using the Original CMAP Weights, ACS 2007, CS-Adjusted CMAP Weights

Households Distribution, CMAP Survey Data with Original CMAP Weights

	Size = 1				Size = 2				Size = 3				Size = 4			
County	0 - Vehicle	1- Vehicle	2- Vehicle	3- Vehicle	0 - Vehicle	1- Vehicle	2- Vehicle	3- Vehicle	0 - Vehicle	1- Vehicle	2- Vehicle	3- Vehicle	0 - Vehicle	1- Vehicle	2- Vehicle	3- Vehicle
Cook	208,948	323,501	27,536	55,937	47,111	234,587	187,274	34,392	62,870	55,773	76,136	161,403	63,623	59,605	284,985	90,976
DuPage	3,755	56,429	9,647	1,022	66	22,476	97,281	4,926	223	5,722	15,413	9,900	908	51,653	36,483	9,303
Kane	3,532	13,597	3,067	596	0	7,662	19,836	3,161	54	2,375	8,352	6,063	12	255	12,821	52,541
Lake	2,362	22,758	1,368	1,384	3,379	5,928	76,396	6,153	231	1,316	5,590	11,634	1,846	2,155	16,938	56,990
McHenry	3,386	10,670	1,168	0	0	2,668	23,711	7,542	0	738	12,316	9,138	0	2,563	9,469	6,125
Will	543	12,406	6,169	124	809	10,015	31,195	6,605	0	788	9,580	9,669	0	2,210	18,286	59,491

Households Distribution in ACS 2007 Dataset

	Size = 1				Size = 2				Size = 3				Size = 4			
County	0 - Vehicle	1- Vehicle	2- Vehicle	3- Vehicle	0 - Vehicle	1- Vehicle	2- Vehicle	3- Vehicle	0 - Vehicle	1- Vehicle	2- Vehicle	3- Vehicle	0 - Vehicle	1- Vehicle	2- Vehicle	3- Vehicle
Cook	194,230	392,250	36,952	6,676	68,787	206,316	253,890	32,930	29,912	97,688	119,848	62,779	43,210	110,880	220,548	139,919
DuPage	7,476	65,439	6,386	2,054	2,005	24,934	62,032	12,952	618	7,216	26,504	20,905	768	7,523	47,396	37,621
Kane	4,743	21,718	3,782	270	675	11,519	27,052	6,065	860	3,183	13,256	7,278	1,145	4,896	24,821	21,016
Lake	6,427	35,852	6,627	1,416	1,341	14,364	46,460	10,286	796	4,896	17,340	13,902	681	5,657	37,000	25,923
McHenry	2,233	13,395	3,046	587	451	5,372	21,148	5,648	502	2,285	7,512	6,247	246	1,622	16,976	13,594
Will	3,589	25,963	5,916	1,092	1,223	11,027	37,505	8,115	894	5,228	16,958	11,850	675	4,548	36,549	27,218

Households Distribution, CMAP Survey Data with CS-Adjusted CMAP Weights

	Size = 1				Size = 2				Size = 3				Size = 4			
County	0 - Vehicle	1- Vehicle	2- Vehicle	3- Vehicle	0 - Vehicle	1- Vehicle	2- Vehicle	3- Vehicle	0 - Vehicle	1- Vehicle	2- Vehicle	3- Vehicle	0 - Vehicle	1- Vehicle	2- Vehicle	3- Vehicle
Cook	194,230	392,250	36,952	6,676	68,787	206,316	253,890	32,930	29,912	97,688	119,848	62,779	43,210	110,880	220,548	139,919
DuPage	7,476	65,439	6,386	2,054	2,005	24,934	62,032	12,953	618	7,216	26,504	20,905	768	7,523	47,396	37,621
Kane	4,743	21,718	3,782	270	0	11,519	27,052	6,065	861	3,183	13,256	7,278	1,145	4,896	24,821	21,016
Lake	6,427	35,852	6,627	1,416	1,341	14,364	46,460	10,286	796	4,896	17,340	13,902	681	5,657	37,000	25,923
McHenry	2,233	13,395	3,046	0	0	5,372	21,148	5,648	0	2,285	7,512	6,247	0	1,622	16,976	13,594
Will	3,589	25,963	5,916	1,092	1,223	11,027	37,505	8,115	0	5,228	16,958	11,850	0	4,548	36,549	27,218

Note: The cells highlighted in yellow represent household categories for which no data were available in the CMAP survey

3.3 Derivation of Person-Level Weights

The household weights attempt to match the distribution of households in the survey with those from ACS 2007. These weights, however, will not guarantee that the *population* totals and distributions across various socio-economic categories will match the ACS totals. Therefore, a person-level weight was deemed necessary. While the household weight from Section 3.2 will be used for summarizing the household-level attributes from the CMAP survey, the person-level weight will be used for all individual-level variables.

A step-by-step description of the derivation of person weights is provided below:

1. Use the household weights described in Section 3.2 to summarize population by county of residence, age cohort, and gender;

2. Summarize the ACS 2007 population categorized by county of residence, age, and gender;

3. Compare the population in each county, age cohort and gender combination from steps 1 and 2 to derive adjustment factors; and

4. Multiply the adjustment factors to the household weights from Section 3.2 to derive the final person weights.

Table 3 shows the comparison of household distributions by county, size, and vehicles as obtained from the original CMAP household weights, the ACS 2007, and the CS-adjusted household weights. As evident from this table, the CS-adjusted CMAP weights provide an improvement relative to the original weights.

Table 3. Distribution of Population by County, Age Cohort, and Gender Using Original CMAP Weights, ACS 2007, CS-Adjusted CMAP Weights

Population Distribution, CMAP Survey Data with CMAP Unadjusted Weights

	Male									Female									
County	< 15 yrs	15-17	18-20	21-24	25-29	30-44	45-64	65-74	75+	< 15 yrs	15-17	18-20	21-24	25-29	30-44	45-64	65-74	75+	Total
Cook	685,663	48,329	421,670	75,314	91,933	436,856	548,062	82,553	64,532	504,095	92,995	344,540	215,012	149,364	465,637	610,460	146,411	105,311	5,088,739
DuPage	109,778	8,124	4,089	10,725	50,254	65,192	75,993	11,660	57,156	47,304	8,325	97,059	11,819	11,649	59,455	133,356	24,262	61,672	847,869
Kane	22,960	48,960	50,519	7,328	5,069	24,217	77,263	4,411	4,365	20,383	2,527	3,141	3,202	6,378	25,118	83,789	5,464	5,648	400,743
Lake	30,609	50,651	51,453	60,085	52,096	26,698	46,819	7,480	6,504	25,497	47,938	48,940	15,296	5,189	74,038	97,500	7,780	10,182	664,754
McHenry	24,667	5,015	4,800	4,674	6,455	21,792	43,082	3,518	3,335	18,365	5,243	4,531	4,980	6,461	25,940	36,737	6,000	3,669	229,262
Will	32,384	54,403	54,649	5,593	6,258	42,154	84,628	8,000	4,599	40,563	4,812	1,816	8,658	9,107	84,487	37,188	9,025	7,081	495,404

Population Distribution in ACS 2007 Dataset

	Male									Female									
County	< 15 yrs	15-17	18-20	21-24	25-29	30-44	45-64	65-74	75+	< 15 yrs	15-17	18-20	21-24	25-29	30-44	45-64	65-74	75+	Total
Cook	568,419	116,580	114,402	150,106	183,731	605,203	630,665	141,867	111,109	543,954	112,720	108,432	147,607	177,173	598,795	686,921	181,332	195,023	5,374,039
DuPage	94,699	20,717	20,191	24,061	26,180	97,432	125,168	24,407	15,911	91,259	19,743	17,302	21,994	23,929	96,985	129,192	27,127	28,532	904,828
Kane	55,770	10,551	10,117	11,385	17,077	50,005	50,604	9,712	5,931	53,043	9,826	8,136	11,097	16,211	46,826	50,083	10,206	10,118	436,697
Lake	77,006	16,274	17,045	17,168	20,731	68,390	84,003	16,423	10,560	73,380	15,449	13,967	14,355	20,812	67,968	84,650	17,855	16,117	652,155
McHenry	32,945	6,556	6,549	6,345	9,949	31,501	36,631	7,363	4,717	31,045	7,115	5,946	6,014	9,812	31,884	34,782	8,241	7,390	284,784
Will	70,185	13,582	12,701	13,950	23,718	66,077	65,216	12,510	7,456	66,469	12,978	10,288	15,159	23,195	65,172	63,909	13,672	12,886	569,123

Population Distribution, CMAP Survey Data with CS-Adjusted CMAP Weights

	Male									Female									
County	< 15 yrs	15-17	18-20	21-24	25-29	30-44	45-64	65-74	75+	< 15 yrs	15-17	18-20	21-24	25-29	30-44	45-64	65-74	75+	Total
Cook	568,419	116,580	114,402	150,106	183,731	605,203	630,665	141,867	111,109	543,954	112,720	108,432	147,607	177,173	598,795	686,921	181,332	195,023	5,374,039
DuPage	94,699	20,717	20,191	24,061	26,180	97,432	125,168	24,407	15,911	91,259	19,743	17,302	21,994	23,929	96,985	129,192	27,127	28,532	904,828
Kane	55,770	10,551	10,117	11,385	17,077	50,005	50,604	9,712	5,931	53,043	9,826	8,136	11,097	16,211	46,826	50,083	10,206	10,118	436,697
Lake	77,006	16,274	17,045	17,168	20,731	68,390	84,003	16,423	10,560	73,380	15,449	13,967	14,355	20,812	67,968	84,650	17,855	16,117	652,155
McHenry	32,945	6,556	6,549	6,345	9,949	31,501	36,631	7,363	4,717	31,045	7,115	5,946	6,014	9,812	31,884	34,782	8,241	7,390	284,784
Will	70,185	13,582	12,701	13,950	23,718	66,077	65,216	12,510	7,456	66,469	12,978	10,288	15,159	23,195	65,172	63,909	13,672	12,886	569,124

3.4 Derivation of Trip-Level Weights

A final weight adjustment related to the work trips reported in the CMAP survey. The person weights developed in Section 3.3 will not guarantee that the county-to-county flows of journey-to-work trips will match the Census estimates. Therefore, a work-trip weight was deemed necessary.

A step-by-step description of the derivation of work trip weights is provided below:

1. Use the person weights described in Section 3.3 to summarize the number of journey-to-work trips interchanged between the six counties in Northeastern Illinois;

2. Summarize the Census 2000 journey-to-work data to obtain interchanges between the six counties;

3. Compare the relative proportions of interchanges between each county pair from steps 1 and 2 to derive adjustment factors; and

4. Multiply the adjustment factors to the person weights from Section 3.3 to derive the work trip weights.

It must be noted that a trip-level weight was derived only for work trips. This is because of the ready availability of the Census journey-to-work database that served as a comprehensive and independent source with which the survey numbers could be compared. Unfortunately, no such data are available for non-work trips. Accordingly, no trip-level adjustment could be made for the non-work trips captured in the survey.

Table 4 shows the comparison of county-to-county journey to work flows with the original CMAP weight, the Census journey-to-work database, and the CS-adjusted work trip weight. We note that the CS-adjusted weights indicate a slightly higher overall number of journey-to-work interchanges. We believe that this slight difference is due to the slight population growth between 2000 and 2007. Despite this minor difference, the CS-adjusted trip weights provide a better replication of the relative proportions of journey-to-work interchanges than the original weights. The interchange between Cook and Kane Counties provides a good example of the better match obtained with the revised weights.

Table 4. Journey-to-Work Interchanges Using Original CMAP Weights, ACS 2007, CS-Adjusted CMAP Weights

Journey-to-Work Trips, CMAP Survey Data with Original CMAP Weights							
	Work County						
Residence County	Cook	DuPage	Kane	Lake	McHenry	Will	Total
Cook	1,730,961	86,691	147,556	44,008	2,612	18,918	2,030,746
DuPage	129,448	253,719	9,284	4,148	2,064	55,807	454,469
Kane	18,394	24,456	244,639	1,149	1,180	1,242	291,060
Lake	43,336	1,774	610	290,601	5,210	40	341,572
McHenry	24,488	1,005	2,725	14,612	67,204	46	110,081
Will	42,939	20,190	461	357	-	169,266	233,214
Grand Total	1,989,565	387,835	405,275	354,877	78,270	245,320	3,461,142
Journey-to-Work Trips from Census Journey-to-Work 2000 Database							
	Work County						
Residence County	Cook	DuPage	Kane	Lake	McHenry	Will	Total
Cook	2,016,860	146,129	18,345	64,250	5,183	24,432	2,275,197
DuPage	152,431	261,308	16,539	5,377	884	9,196	445,736
Kane	34,360	34,318	101,254	3,012	5,056	1,840	179,839
Lake	83,501	6,967	1,383	199,125	5,866	389	297,230
McHenry	31,337	4,650	8,877	16,730	63,052	343	124,989
Will	76,571	43,497	3,432	1,128	158	100,415	225,202
Grand Total	2,395,060	496,868	149,829	289,622	80,198	136,616	3,548,193
Journey-to-Work Trips, CMAP Survey Data with CS-Adjusted CMAP Weights							
	Work County						
Residence County	Cook	DuPage	Kane	Lake	McHenry	Will	Total
Cook	2,140,096	149,965	28,327	77,728	6,184	35,464	2,437,763
DuPage	139,778	271,690	14,941	10,843	2,912	16,185	456,349
Kane	30,519	40,838	117,155	2,065	2,114	4,374	197,067
Lake	83,679	3,895	1,208	213,926	6,946	75	309,730
McHenry	27,025	1,697	4,802	17,235	74,749	119	125,626
Will	72,967	34,999	900	587	-	141,773	251,226
Total	2,494,064	503,084	167,333	322,384	92,905	197,991	3,777,761

4.0 Additional Comparisons

As described in Section 3, the household weights were adjusted by comparing survey and ACS 2007 distributions of households by county, household size and vehicle ownership. Because household size and vehicle ownership were explicitly used in the weight calculation process, the survey distributions will closely match ACS 2007 distributions for these two attributes. As an additional check of the weights, however, it is necessary to compare the distributions of other important socio-economic variables in the survey with those from ACS 2007.

This section presents the following additional comparative tabulations:

1. Distribution of households by county, household size, and number of workers (**Table 5**);

2. Distribution of households by county and income (**Table 6**); and

3. Distribution of people aged 16 years and over by county and employment status (**Table 7**)

Tables 5 through 7 generally indicate a good agreement between the tabulations resulting from the CS-adjusted CMAP weights and those from ACS 2007. The tables also indicate some areas of difference between the CMAP and ACS tabulations. This is only to be expected because no weighting scheme can be expected to perfectly match household and person tabulations for every single socio-economic attribute.

5.0 Summary and Conclusions

This memorandum described a "tiered" methodology that CS developed for adjusting the original CMAP weights. The methodology used the original weights as a starting point and generated three separate weights:

1. Household weights that should be used to summarize household-level attributes and travel patterns;

2. Person weights that should be applied for summarizing person-level attributes such as gender, age, employment status; and

3. Work trip weights that should be used for summarizing the attributes of work trips including destination, mode, and time-of-day.

Therefore, the CS adjustment methodology derived three separate weights instead of a single household weight that would apply to every person in the household and every trip made by members of the household. It should be noted that the weight adjustments were made only for households and persons residing in the six-county region in Northeastern Illinois. No adjusted weights were derived for the three Indiana counties. Should the data user find it necessary to analyze data in these regions, it may be helpful to develop adjusted weights using the methodology described in this memorandum.

As a final note of caution, we would like to point out that the derivation of survey weights often requires a combination of statistical techniques and local judgment. It is highly likely that an independent data user could come up with different household weights by using a different choice of socio-economic variables and independent data sources. The weights derived by CS are geared towards analyzing data for the RTA Travel Market Analysis project. The focus of this study is more on general travel patterns and behavior and not on understanding household-level travel decision making. Therefore, for other uses such as four-step travel demand modeling, users may find the need to further adjust the weights derived using the CS methodology.

Table 5. Households by County, Household Size and Number of Workers Using CS-Adjusted CMAP Weight and ACS 2007

Households Distribution, CMAP Survey Data with CS-Adjusted CMAP Weight													
	HH Size = 1		HH Size = 2			HH Size = 3				HH Size = 4			
County	Workers = 0	Workers = 1	Workers = 0	Workers = 1	Workers = 2	Workers = 0	Workers = 1	Workers = 2	Workers = 3	Workers = 0	Workers = 1	Workers = 2	Workers = 3
Cook County, IL	219,607	410,500	94,294	186,378	281,251	15,841	101,225	146,995	46,167	32,546	134,487	238,161	109,363
DuPage County, IL	18,435	62,920	14,614	30,681	56,628	2,304	14,806	24,257	13,876	316	24,229	45,105	23,657
Kane County, IL	10,463	20,051	7,110	11,417	26,109	305	8,076	10,435	5,762	-	15,794	20,620	15,462
Lake County, IL	17,976	32,345	14,465	17,568	40,419	160	9,917	18,339	8,518	461	15,962	34,588	18,250
McHenry County, IL	4,513	14,160	4,869	8,140	19,160	1,108	5,027	6,929	2,981	-	11,161	16,463	4,568
Will County, IL	14,691	21,870	6,129	22,868	28,872	1,038	15,338	16,255	1,405	740	15,961	45,574	6,039
Households Distribution in ACS 2007 Dataset													
	HH Size = 1		HH Size = 2			HH Size = 3				HH Size = 4			
County	Workers = 0	Workers = 1	Workers = 0	Workers = 1	Workers = 2	Workers = 0	Workers = 1	Workers = 2	Workers = 3	Workers = 0	Workers = 1	Workers = 2	Workers = 3
Cook County, IL	254,887	351,451	143,754	188,701	208,271	37,719	114,909	110,133	35,764	42,464	162,216	187,849	102,617
DuPage County, IL	32,281	50,578	24,293	34,164	45,351	3,018	17,756	26,907	8,583	3,992	30,150	39,614	21,277
Kane County, IL	13,858	19,014	10,698	17,321	20,794	1,460	9,338	12,329	3,350	2,749	17,592	21,801	13,744
Lake County, IL	19,755	31,656	15,735	25,575	32,710	2,119	12,251	17,415	5,948	2,685	24,099	32,300	11,676
McHenry County, IL	8,256	12,156	8,424	10,559	15,587	1,417	5,903	7,318	2,898	2,070	11,836	14,438	6,034
Will County, IL	16,088	23,988	14,865	21,235	27,334	3,092	13,012	17,829	4,356	4,480	26,701	30,268	14,174

Table 6. Proportion of Households by County and Income Using CS-Adjusted CMAP Weight and ACS 2007

Households Distribution, CMAP Survey Data with CS-Adjusted CMAP Weight								
	Household Income							
County	Less than $20,000	$20,000 - $34,999	$35,000 - $49,999	$50,000 - $59,999	$60,000 to $74,999	$75,000 to $99,999	More than $100,000	All HH
Cook County, IL	11.1%	11.3%	9.9%	5.4%	7.4%	8.2%	13.7%	66.9%
DuPage County, IL	0.9%	1.3%	1.5%	1.1%	1.3%	1.8%	3.0%	11.0%
Kane County, IL	0.6%	0.5%	0.7%	0.4%	0.9%	0.6%	1.3%	5.0%
Lake County, IL	0.7%	1.0%	1.0%	0.3%	1.0%	1.0%	2.2%	7.2%
McHenry County, IL	0.1%	0.5%	0.4%	0.3%	0.7%	0.5%	0.8%	3.3%
Will County, IL	0.6%	0.8%	1.0%	0.6%	1.2%	0.9%	1.4%	6.5%
Entire 6-County Area	14.0%	15.5%	14.5%	8.2%	12.5%	13.0%	22.4%	100.0%
Households Distribution in ACS 2007 Dataset								
	Household Income							
County	Less than $20,000	$20,000 - $34,999	$35,000 - $49,999	$50,000 - $59,999	$60,000 to $74,999	$75,000 to $99,999	More than $100,000	All HH
Cook County, Illinois	11.9%	9.8%	8.8%	5.2%	6.7%	8.1%	14.2%	64.7%
DuPage County, Illinois	0.9%	1.1%	1.5%	0.9%	1.3%	1.6%	3.9%	11.3%
Kane County, Illinois	0.6%	0.7%	0.7%	0.4%	0.6%	0.9%	1.6%	5.5%
Lake County, Illinois	0.7%	0.8%	0.9%	0.6%	0.8%	1.2%	2.9%	7.8%
McHenry County, Illinois	0.3%	0.4%	0.4%	0.3%	0.4%	0.6%	1.1%	3.6%
Will County, Illinois	0.7%	0.7%	0.9%	0.7%	0.9%	1.3%	2.2%	7.2%
Entire 6-County Area	15.1%	13.5%	13.1%	8.2%	10.7%	13.6%	25.8%	100.0%

Note 1: The numbers presented here represent percentage of total households in the region.

Note 2: This table presents proportions instead of the actual number of households because some households in the CMAP survey did not report income. Therefore, a comparison of proportions will generate more meaningful comparisons.

Table 7. Distribution of People Aged 16 Years and Over by County and Employment Status Using CS-Adjusted CMAP Weight and ACS 2007

Population Distribution, CMAP Survey Data with CS-Adjusted CMAP Weight					
	Employment Status				
County	Employed full time (30+ hrs/wk)	Employed part time (<30 hrs/wk)	Homemaker or did not work, Age 16 and up	Retired	All HH
Cook County, IL	2,203,350	580,910	770,166	541,361	4,095,787
DuPage County, IL	414,131	113,213	87,675	75,243	690,262
Kane County, IL	182,233	48,438	51,552	30,780	313,003
Lake County, IL	285,142	64,603	73,248	52,949	475,942
McHenry County, IL	117,726	27,166	40,724	23,534	209,150
Will County, IL	226,914	62,703	83,248	39,843	412,708
Entire 6-County Area	3,429,496	897,033	1,106,613	763,710	6,196,852
Population Distribution in ACS 2007 Dataset					
	Employment Status				
County	Employed full time (35+ hrs/wk)	Employed part time (1-34 hrs/wk)	Did not work, Age 16-64	Did not work, Age 65 and up	All persons 16 and older
Cook County, Illinois	2,245,580	572,939	799,187	501,428	4,119,134
DuPage County, Illinois	424,149	123,792	101,385	76,354	725,680
Kane County, Illinois	223,249	58,674	52,901	32,514	367,338
Lake County, Illinois	321,336	87,534	79,339	48,029	536,238
McHenry County, Illinois	140,465	43,983	31,827	23,541	239,816
Will County, Illinois	290,710	83,198	83,315	44,885	502,108
Entire 6-County Area	3,645,490	970,119	1,147,954	726,751	6,490,314

Note: The employment status definitions were different in the CMAP survey and in the ACS 2007. This table tries to match these definitions as best as possible. The reader is advised to keep this in mind while comparing the two tables.